PB-215 486

REPORT FOR CONSULTATION ON THE METROPOLITAN MILWAUKEE INTRASTATE AIR QUALITY CONTROL REGION

National Air Pollution Control Administration
Washington, D. C.

June 1969

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration
June 1969

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PREFACE

The Secretary, Department of Health, Education, and Welfare is directed by the Air Quality Act of 1967 to designate "air quality control regions" as an initial step toward the establishment of regional air quality standards and the implementation of air quality control programs. In addition to listing the major factors to be considered in the development of region boundaries, the Act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities.

The National Air Pollution Control Administration, DHEW, has conducted a study of the greater Milwaukee area, the results of which are presented in this report. The Region* boundaries proposed in this report reflect consideration of available and pertinent data; however, the boundaries remain subject to revision suggested by consultation with State and local authorities. Formal designation will be withheld pending the outcome of the meeting. This report is intended to serve as the starting point for the consultation.

The Administration is appreciative of assistance received either directly during the course of this study or indirectly during previous studies from the official air pollution agencies of the affected state and counties, the Southeastern Wisconsin Regional Planning Commission, and the Bureau of State Planning.

*For the purposes of this report, the word "region," when capitalized, will refer to the proposed Metropolitan Milwaukee Intrastate Air Quality Control Region. When not capitalized, unless otherwise noted, it will refer to air quality control regions in general.

INTRODUCTION

> "For the purpose of establishing ambient air quality standards pursuant to section 108, and for administrative and other purposes, the Secretary, after consultation with appropriate State and local authorities, shall, to the extent feasible, within 18 months after the date of enactment of the Air Quality Act of 1967 designate air quality control regions based on jurisdictional boundaries, urban-industrial concentrations, and other factors including implementation of air quality standards. The Secretary may from time to time thereafter, as he determines necessary to protect the public health and welfare and after consultation with appropriate State and local authorities, revise the designation of such regions and designate additional air quality control regions. The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."
>
> Section 107(a), Air Quality Act of 1967

Air pollution, because of its direct relationship to people and their activities, is an urban problem. Urban sprawls often cover thousands of square miles; they quite often include parts of more than one State and almost always are made up of several counties and an even greater number of cities. Air pollution, therefore, also becomes a regional problem, and the collaboration of several governmental jurisdictions is prerequisite to the solution of the problem in any given area. Air quality control regions called for in the above-quoted section of the Air Quality Act of 1967 are meant to define the geographical extent of air pollution problems in different urban areas and the combination of jurisdictions that must contribute to the solution in each.

The regional approach set up by the Air Quality Act is illustrated in Figure 1. The approach involves a series of steps to be taken by Federal, State, and local governments, beginning with the designation of regions, the publication of air quality criteria, and the publication of information on available control techniques by the Federal Government. Following the completion of these three steps, the Governors of the States involved in a region designation must file with the Secretary within 90 days a letter of intent, indicating that the States will adopt within 180 days air standards and within another 180 days plans for the implementation, maintenance, and enforcement of those air quality standards in the designated air quality control regions.

The new Federal legislation provides for a regional attack on air pollution and, at the same time, allows latitude in the form which regional efforts may take. While the Secretary reserves approval authority, the States involved in a designated region assume the responsibility for developing air quality standards and an implementation plan which includes administrative procedures for abatement and control.

The basic objective in the designation of an air quality control region is that it be self-contained, i.e. that the transfer of air pollution out of or into a region is minimized. This objective recognizes the fact that an air quality control region cannot be delineated in a way to make it completely independent with respect to the air pollution problem. Because air polluants can be carried long distances, the air over a region can be subjected occasionally or

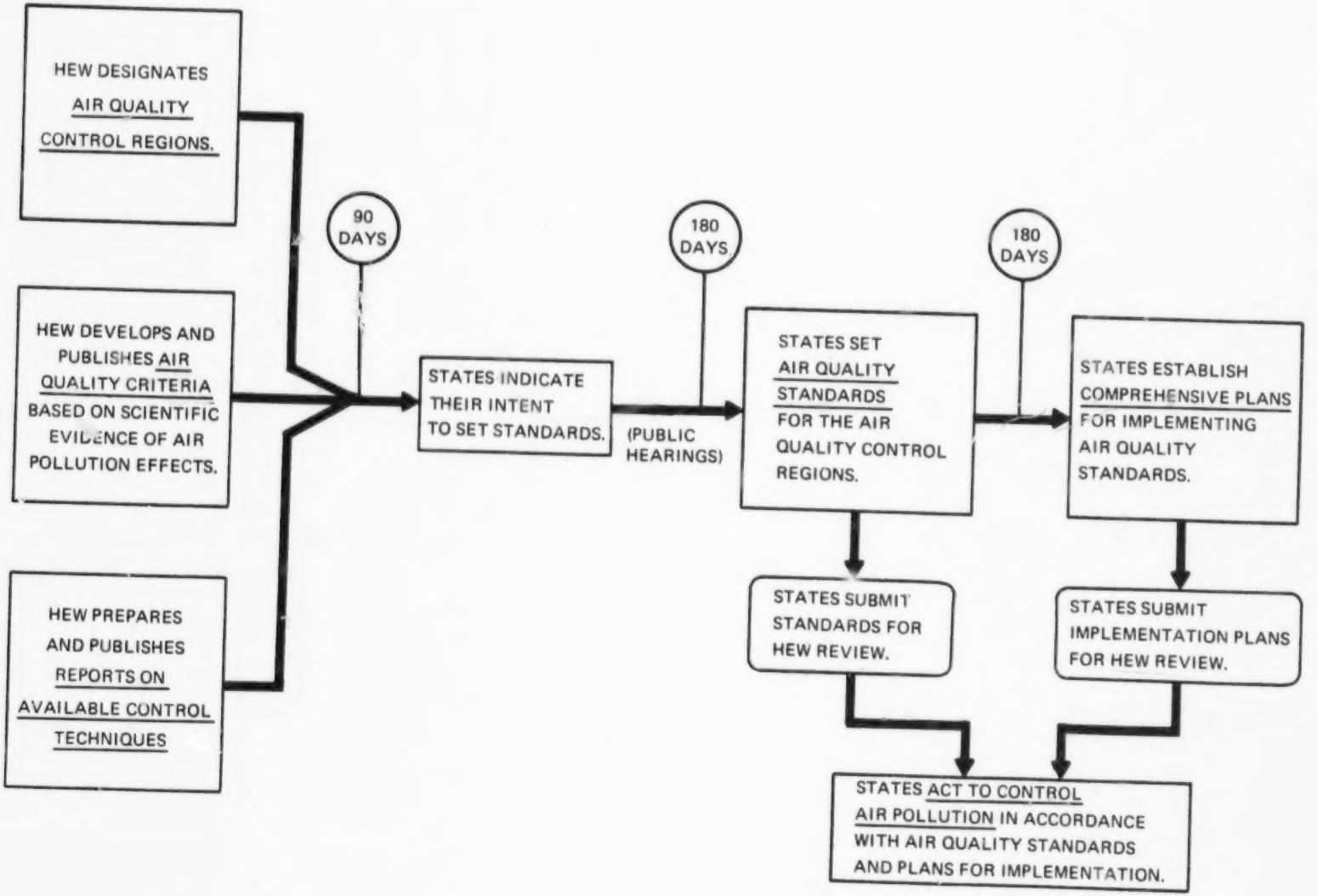

HEW DESIGNATES AIR QUALITY CONTROL REGIONS.
HEW DEVELOPS AND PUBLISHES AIR QUALITY CRITERIA BASED ON SCIENTIFIC EVIDENCE OF AIR POLLUTION EFFECTS.
HEW PREPARES AND PUBLISHES REPORTS ON AVAILABLE CONTROL TECHNIQUES
90 DAYS
STATES INDICATE THEIR INTENT TO SET STANDARDS.
180 DAYS
(PUBLIC HEARINGS)
STATES SET AIR QUALITY STANDARDS FOR THE AIR QUALITY CONTROL REGIONS.
180 DAYS
STATES ESTABLISH COMPREHENSIVE PLANS FOR IMPLEMENTING AIR QUALITY STANDARDS.
STATES SUBMIT STANDARDS FOR HEW REVIEW.
STATES SUBMIT IMPLEMENTATION PLANS FOR HEW REVIEW.
STATES ACT TO CONTROL AIR POLLUTION IN ACCORDANCE WITH AIR QUALITY STANDARDS AND PLANS FOR IMPLEMENTATION.

Figure 1 FLOW DIAGRAM FOR ACTION TO CONTROL AIR POLLUTION ON A REGIONAL BASIS, UNDER THE AIR QUALITY ACT.

even frequently to trace amounts of pollution from other cities and individual sources located outside its boundaries. Under episodic conditions such contributions can even reach significant quantities. The problem of a boundary designation is further compounded in that urban areas generally do not end abruptly but are surrounded by activities that can contribute to the pollution of the urban area as well as be the recipients of its generated pollution. Consideration of all these possibilities would result in regions substantially larger than is practical or even necessary to get to the brunt of the problem. The boundaries of regions, however, should encompass areas that contain sources that add significantly to the pollution load of the air as well as the areas that are significantly and continuously affected by it. For this purpose, the delineation of regional boundaries is based on evaluation of annual and seasonal air pollutant emissions and resultant ambient concentrations rather than those based on short-term and specific conditions.

The selection of regional boundaries should not be based solely on today's conditions and needs, but, perhaps more importantly, should give consideration to future development and growth of the area. Consideration should be given to prescribed metropolitan plans as well as the forecasted growth. Such considerations should result in the designation of regions that will contain the region-wide air pollutant source-receptor system for a number of years to come. This is not to say that the regional boundaries should remain stationary and unchanged. Periodic review of boundaries is desirable, and changes in the boundary should be considered if conditions warrant.

The delineation of region boundaries solely on the basis of source locations and distributional patterns of ambient air pollution would most likely result in regions that do not follow any existing governmental boundaries, are difficult to define, and, more importantly, extremely difficult if not impossible to administrate. It is for this reason that existing jurisdictional entities are reviewed; wherein practical the boundary lines of a region include that combination of whole jurisdictions which encompasses the problem area. There can be exceptions to that philosophy, however The presence of overly large jurisdictions, marked topographical features (mountains), or notable differences in development within a given jurisdiction may, in some cases, make it desirable to include only portions of some jurisdictions.

A region, then, will represent a balance between the various objectives discussed so far to the extent that any two of them lead to different conclusions. The strength of some factors over others may lead to region boundaries which exclude some sources of pollution that might affect the air quality of part or all of the nearby region under certain conditions. Even though the impact of such sources would probably be minimal, the implementation plan required under the Air Quality Act for the region should provide a mechanism for the control of point sources that are located just beyond the region boundary. Such a provision would be consistent with the basic objective of providing desirable air quality within an area being designated as an air quality control region.

Figure 2 summarizes the procedure used by the National Air Pollution Control Administration for designating air quality control regions.

A preliminary delineation of the region is developed by bringing together two essentially separate studies--the "Evaluation of Engineering Factors" and the "Evaluation of Urban Factors."

The study of "Engineering Factors" indicates the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. Pollutant sources are located by an inventory of emissions from automobiles, industrial activities, space heating, waste disposal, and other pollution generators. Pollutant concentrations in the ambient air are estimated from air quality sampling data by a theoretical diffusion model. When it exists, air quality sampling data is more reliable than the theoretical diffusion model results since the data is directly recorded by pollutant measuring instruments. Unfortunately, in many cases extensive air quality sampling data is unavailable in the rural areas surrounding an urban complex.

The study of "Urban Factors" encompasses all non-engineering considerations. It reviews existing governmental jurisdictions, current air pollution control programs, present concentrations of population and industry, and expected patterns of urban growth. Other non-engineering factors are discussed when they are relevant. As a whole, the study of urban factors indicates how large an air quality control region must be in order to encompass expected growth of

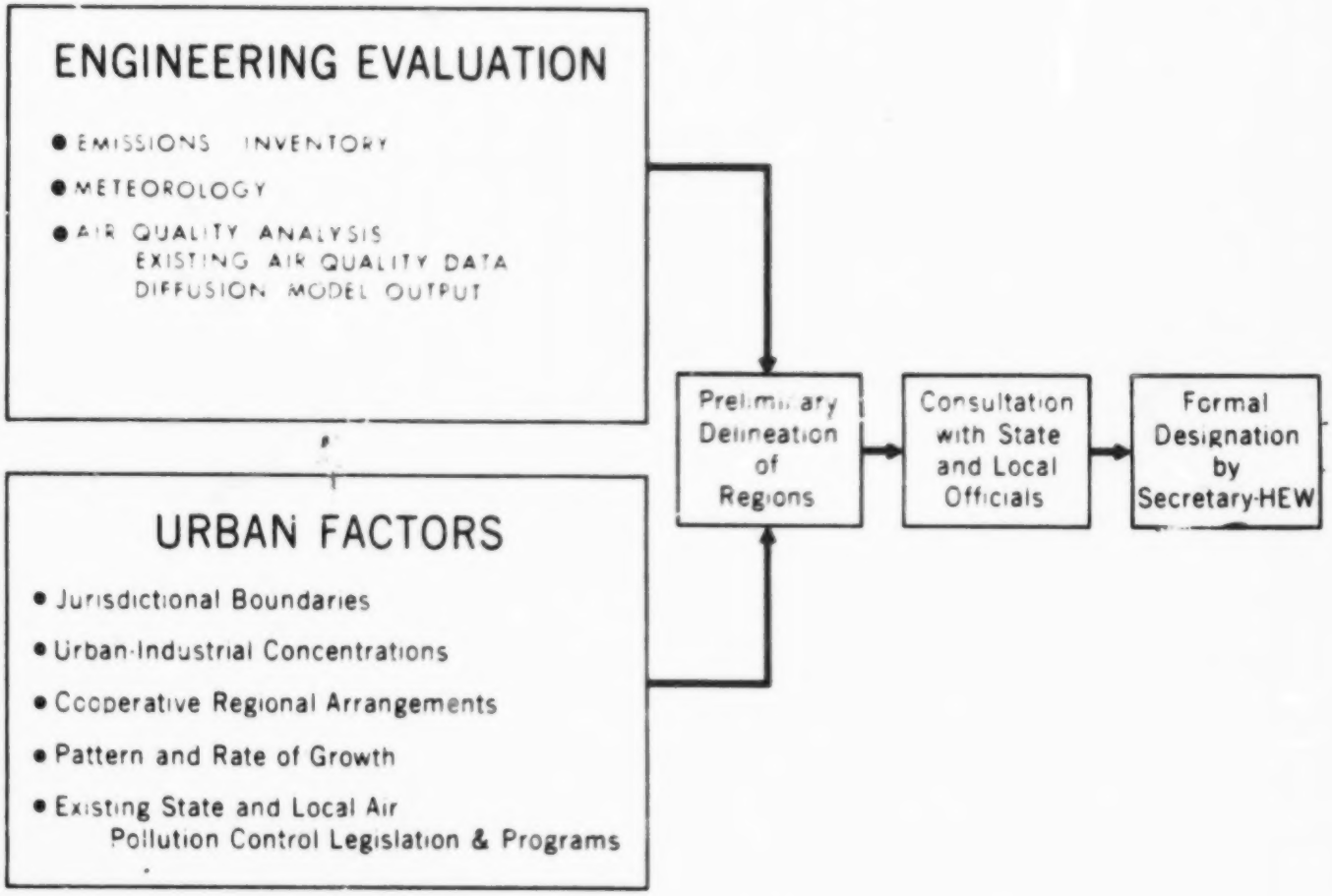


Figure 2. Flow diagram for the designation of air quality control regions.

pollution sources in the future. It also considers which group of governmental jurisdictions will most effectively administer a strong regional air quality control program.

The conclusions of the engineering study are combined with the results of the urban factors study to form the basis of an initial proposal for an air quality control region. As shown in Figure 2, the proposal is then submitted for consultation with State and local officials. After reviewing the suggestions raised during the consultation, the Secretary formally designates the region with a notice in the Federal Register and notifies the Governors of the States affected by the designation.

The body of this report contains a proposal for the boundaries of the Metropolitan Milwaukee Intrastate Air Quality Control Region and supporting studies on engineering and urban factors. The report itself is intended to serve as the background document for the formal consultation with appropriate State and local authorities.

EVALUATION OF ENGINEERING FACTORS

The engineering evaluation for the Milwaukee area was based on a study of topography, air pollutant emissions, meteorology, estimated air quality levels, and available ambient air quality data. The emission inventory indicated the location of point and area sources and the quantity of pollutants emitted from these sources. Emission densities were calculated from the emission quantities and grid zone areas. Emissions and average meteorological data were used in a diffusion model[1] to estimate air quality levels in the Milwaukee study area.*

TOPOGRAPHY

Four of the seven counties in the study area border Lake Michigan; Ozaukee, Milwaukee, Racine, and Kenosha account for approximately 100 miles of Lake Michigan shoreline. The land near the lake is fairly flat and slowly changes to gently rolling prairie terrain towards the western side of the study area. The Menomonee and the Milwaukee Rivers converge in the center of urban Milwaukee, producing a harbor for Lake Michigan water commerce.

METEOROLOGY

The climate in the Milwaukee study area is influenced by the general storms which move eastward along the northern border of the United States and by those which move from the southwestern part of the country to the Great Lakes. The high barometric pressure systems which move eastward or southeastward across the country also affect the area. For this reason the weather changes frequently.

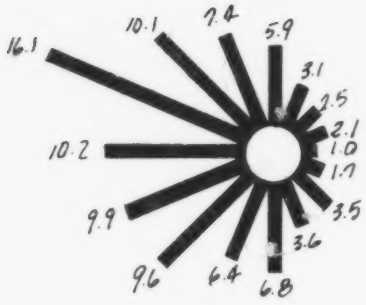
* The Milwaukee study area refers to the seven counties of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha.

The shore areas are also influenced by Lake Michigan, especially in the spring, summer, and fall, when the Lake water temperature varies to a great extent from the air temperature. During the spring and early summer, a shift of wind from a westerly to an easterly direction frequently causes a sudden 10^{o}-15^{o} drop in daytime temperatures. In the autumn, the relatively warm water of the Lake prevents nighttime temperatures on the shore line from falling as low as they do a few miles inland.

Annual and seasonal wind roses for the Milwaukee area are shown in Figure 3. During the winter months, the frequency of occurrence of wind from the western directions (NNW-SSW) is greatest indicating that air pollution in the study area is transported most of the time towards Lake Michigan. Wind roses for summer and annual conditions are more evenly balanced.

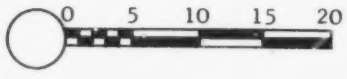
EMISSIONS INVENTORY

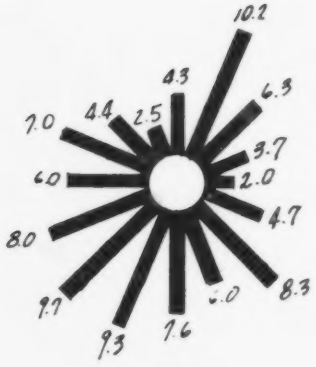
The National Air Pollution Control Administration conducted an inventory of air pollutant emissions for the Milwaukee area.[2] Five pollutants were inventoried--sulfur oxides, total particulates, carbon monoxide, hydrocarbons, and nitrogen oxides. Sulfur oxides, total particulates and carbon monoxide are considered in this report since they provide an indication of the general geographic extent of the overall problem. Sulfur oxides pollution levels illustrate the impact of fuel burning activities at stationary sources. Levels of carbon monoxide provide the best indication of the impact of gasoline-powered motor vehicles on the regional air pollution pattern. Particulate emissions primarily show the extent of industrial, power,



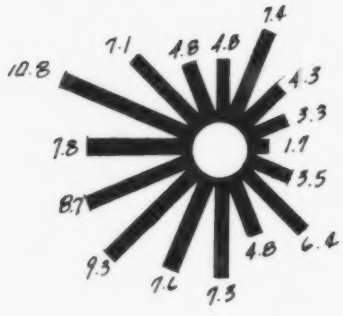
Winter

Figure 3. Percent Frequency of Wind Direction for Various Averaging Times, Based on 1951-1960 Data.





Summer



Annual

incineration, and heating sources. Results of the emissions inventory are tabulated in Table 1.

Figure 4 breaks the total emissions down into percent contribution by the various source categories. Power plants emit the majority of sulfur oxides pollution (69% of the total). Total particulate emissions are more evenly distributed by source category; industrial sources contribute 45% and power plants, 28% of the total. Transportation sources contribute the over-whelming majority of carbon monoxide pollution. Approximately 94% of all CO emitted in the study area is attributed to transportation sources.

To show the geographical distribution of emissions, the study area was divided into the grid system shown in Figure 5. The estimated annual emissions of each of the three pollutants by grid zone were converted to average daily emissions for average, maximum, and minimum space heating days. Average emission densities were determined by relating the total quantity of pollutants emitted in each of the grid zones to the land area of each zone. The resulting emission densities for average space-heating days are shown in Figures 6, 7, and 8. The general pattern of emission densities for each of the three pollutants is closely related to the pattern of urbanization in the Milwaukee area.

Figure 9 shows the major point sources in the study area which contribute to the air pollution problem.

AIR QUALITY ANALYSIS

The geographical distribution of pollutant sources illustrates the core of the problem area. It does not, however, elucidate the

Table I. Pollutant Emissions by Source Category and Political Jurisdiction in the Milwaukee Area (Tons/Year)

	County	Industrial	Commercial and Institutional	Residential	Power Plants	Total Fuel	Industrial Process Losses	Transportation	Refuse Disposal	Total
SULFUR OXIDES	Kenosha	1760	10	1990	---	3760	---	175	Neg	3935
	Milwaukee	42300	70	15920	144900	203190	220	1390	240	205040
	Ozaukee	500	NA	810	28120	29430	---	135	Neg	29565
	Racine	2900	10	2480	---	5390	---	355	Neg	5745
	Walworth	NA	NA	520	---	520	---	70	Neg	590
	Washington	175	NA	890	---	1065	---	140	Neg	1205
	Waukesha	130	NA	3170	---	3300	---	495	Neg	3795
	Total	47765	90	25780	173020	246655	220	2760	240	249875
PARTICULATES	Kenosha	2190	10	440	---	2640	15	300	430	3385
	Milwaukee	40000	110	3500	16330	59940	2400	4575	6730	73645
	Ozaukee	315	NA	180	12000	12495	55	240	180	12970
	Racine	2810	10	550	---	3370	180	560	560	4670
	Walworth	NA	NA	110	---	110	---	110	180	400
	Washington	75	NA	200	---	275	40	210	190	715
	Waukesha	90	NA	700	---	790	2240	790	660	4480
	Total	45480	130	5680	28330	79620	4930	6785	8930	100265
CARBON MONOXIDE	Kenosha	80	---	460	---	540	---	28030	2300	30870
	Milwaukee	1300	---	3710	840	5850	---	344030	19790	369670
	Ozaukee	10	NA	190	190	390	---	20790	930	22110
	Racine	90	---	580	---	670	---	60550	2950	64170
	Walworth	NA	NA	120	---	120	---	13960	960	15040
	Washington	10	NA	210	---	220	---	25920	1000	27140
	Waukesha	5	NA	740	---	745	---	87740	3510	91995
	Total	1495	Neg.	6010	1030	8535	---	581020	31440	620995

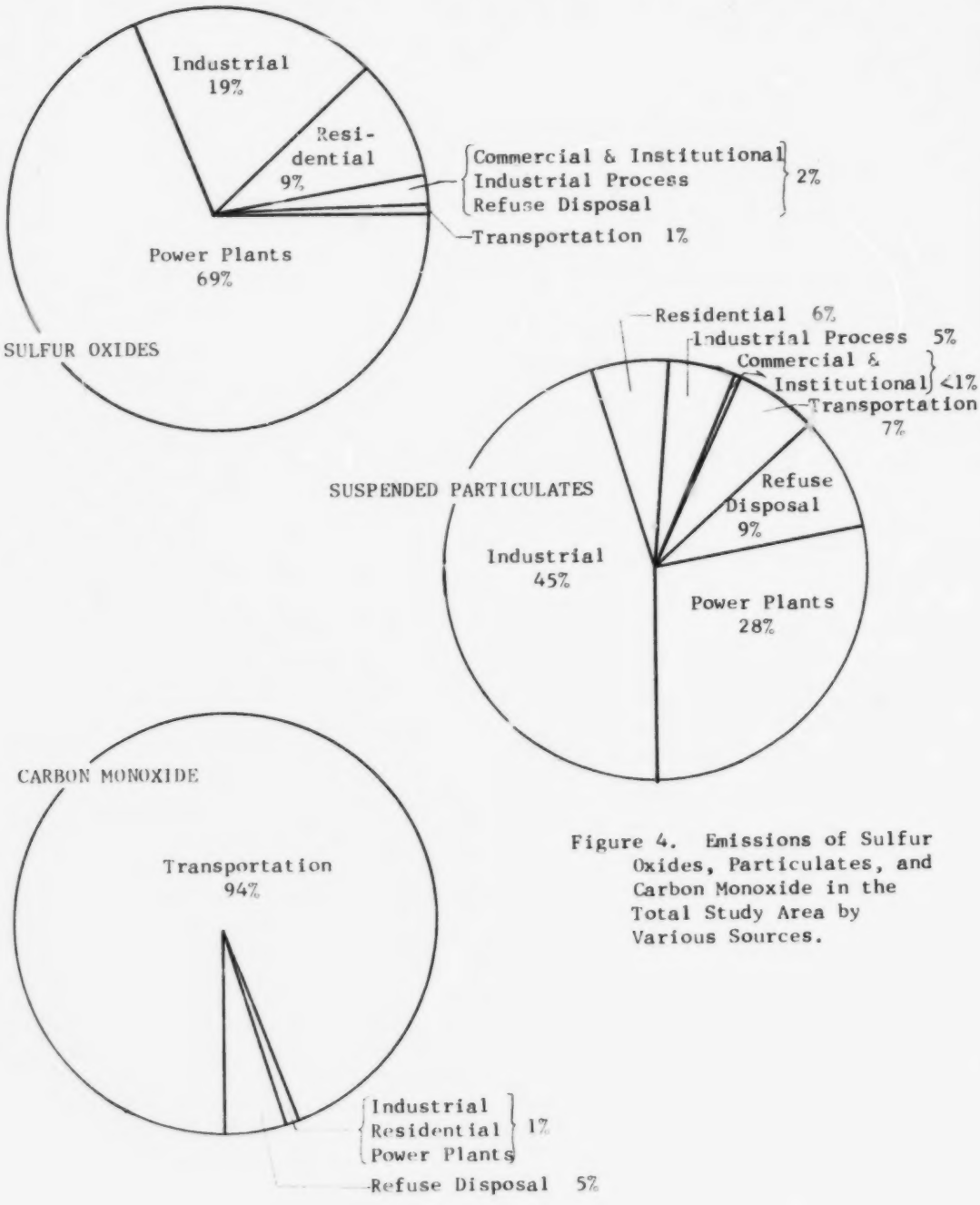


Figure 4. Emissions of Sulfur Oxides, Particulates, and Carbon Monoxide in the Total Study Area by Various Sources.

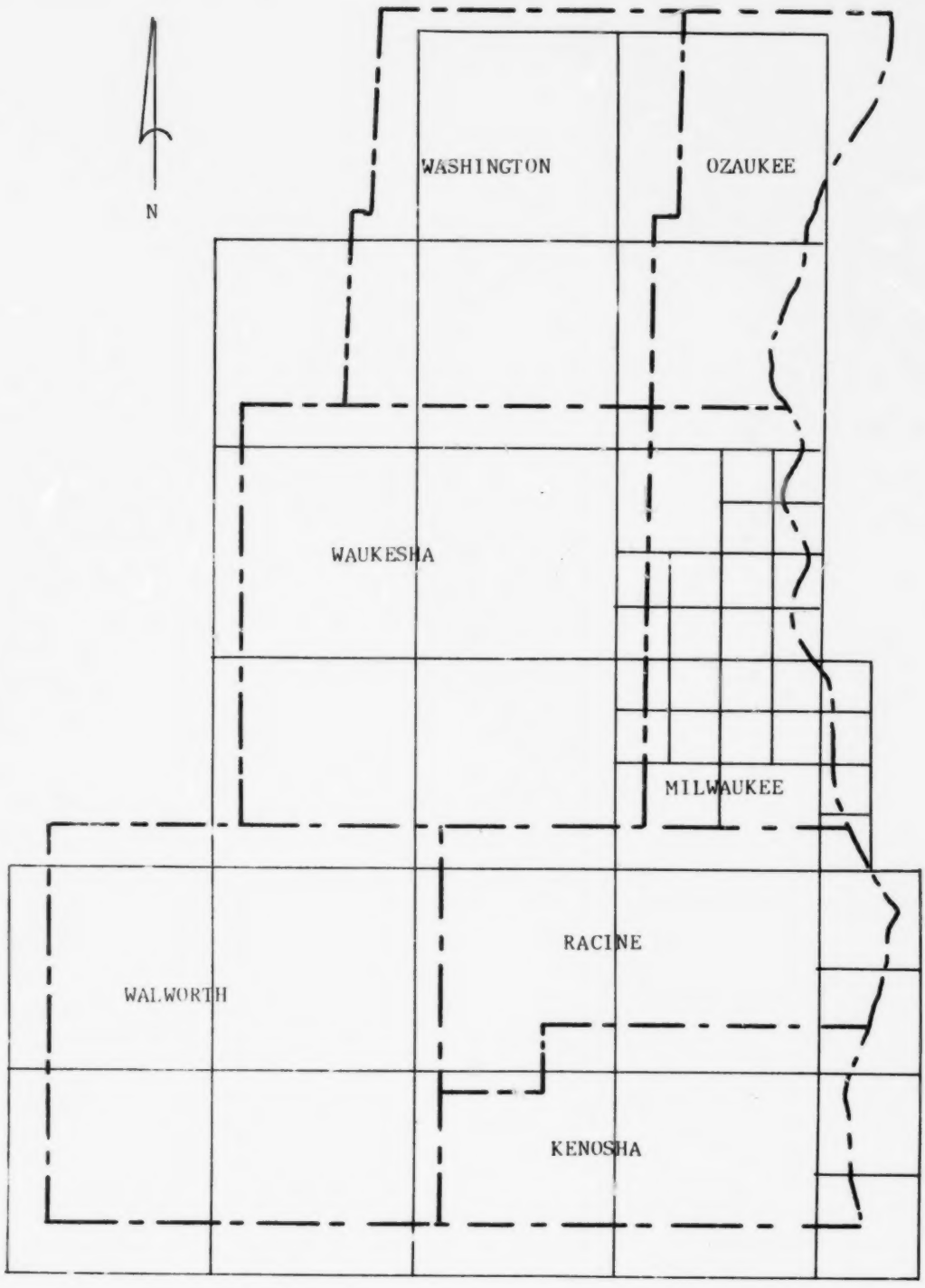


Figure 5. The Milwaukee Study Area Grid Coordinate System.

Figure 6. Mean daily density of particulates in the Milwaukee study area, 1967.

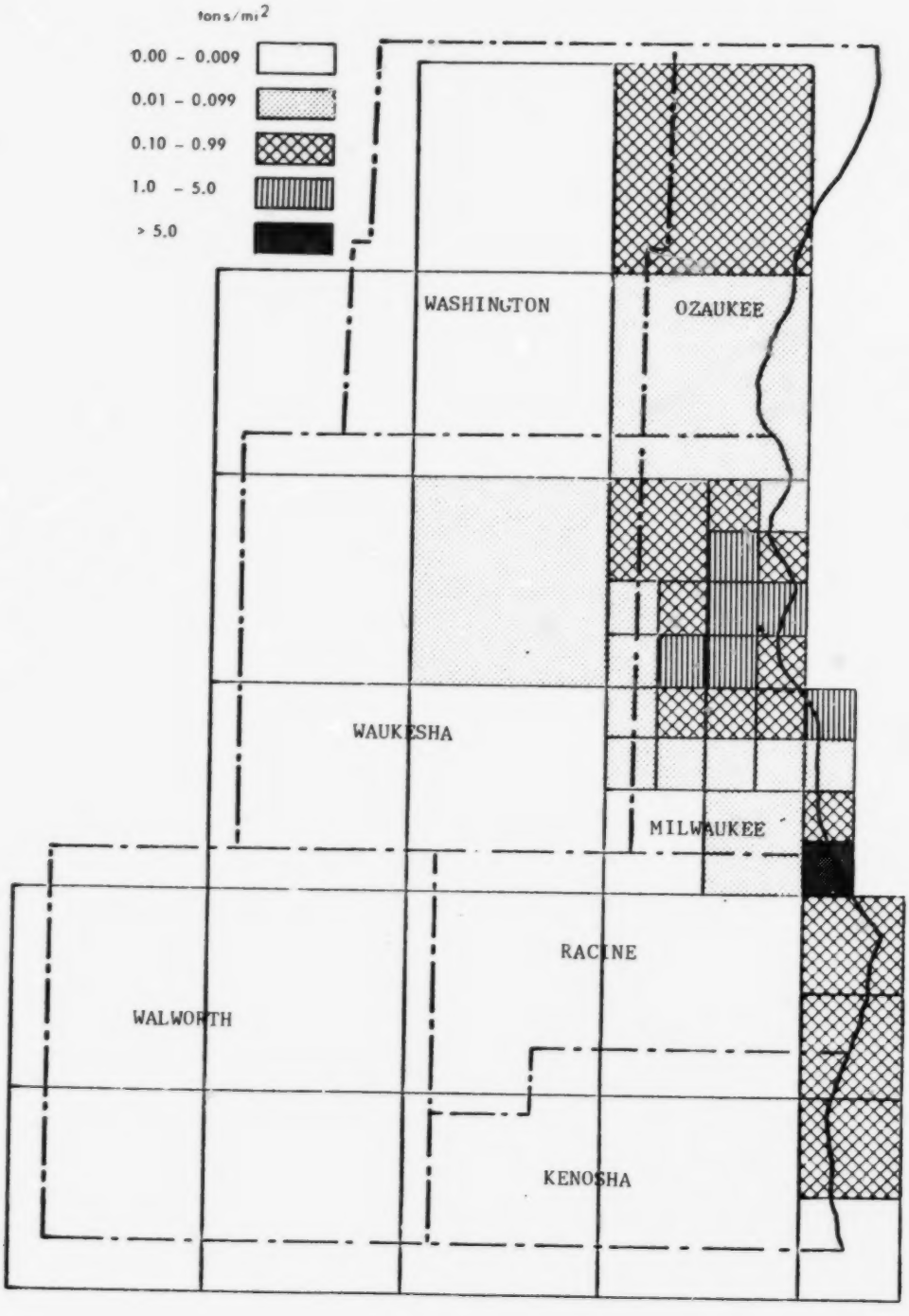


Figure 7. Mean daily density of sulfur oxides in the Milwaukee study area, 1967.

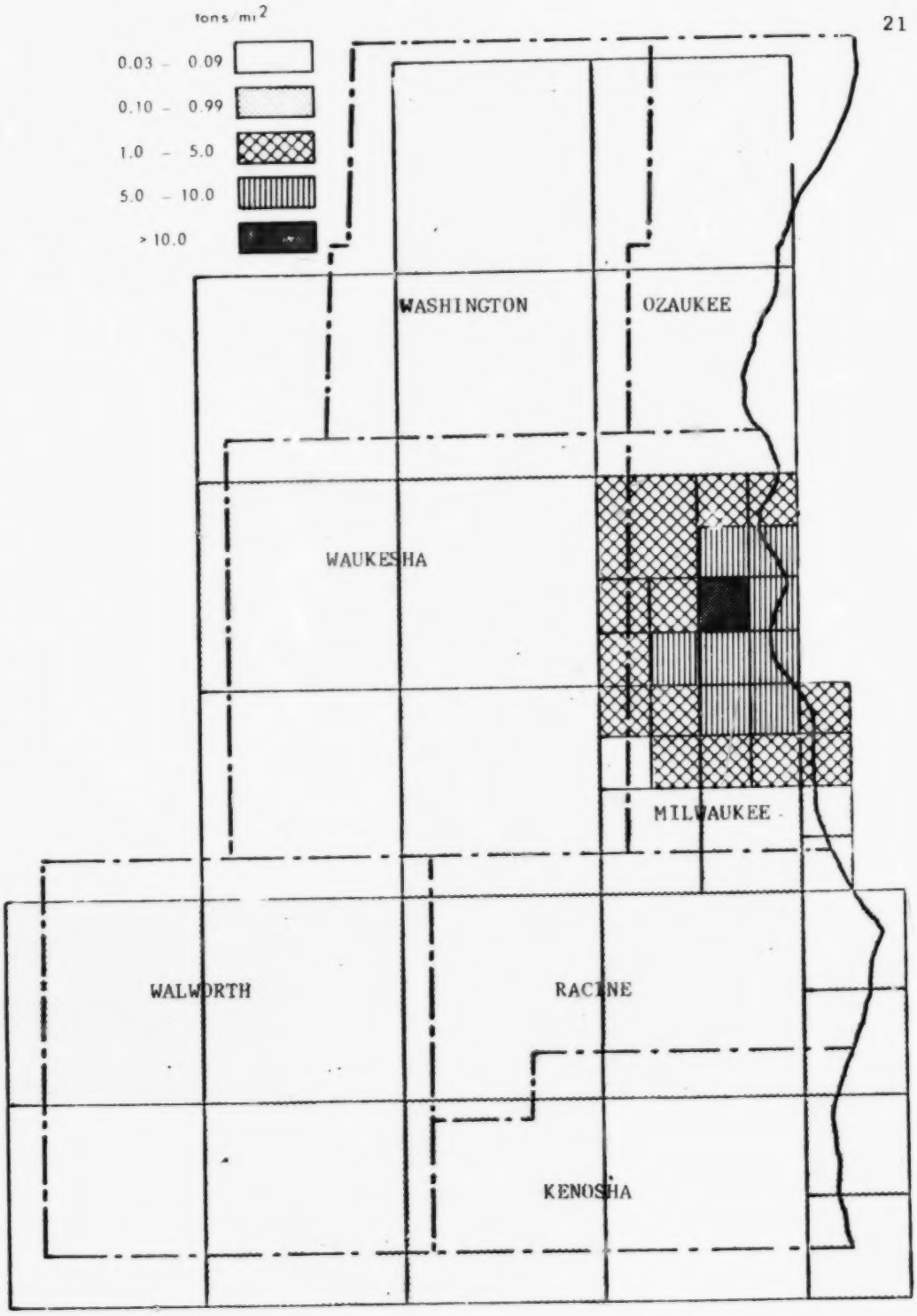


Figure 8. Mean daily density of carbon monoxide in the Milwaukee study area, 1967.

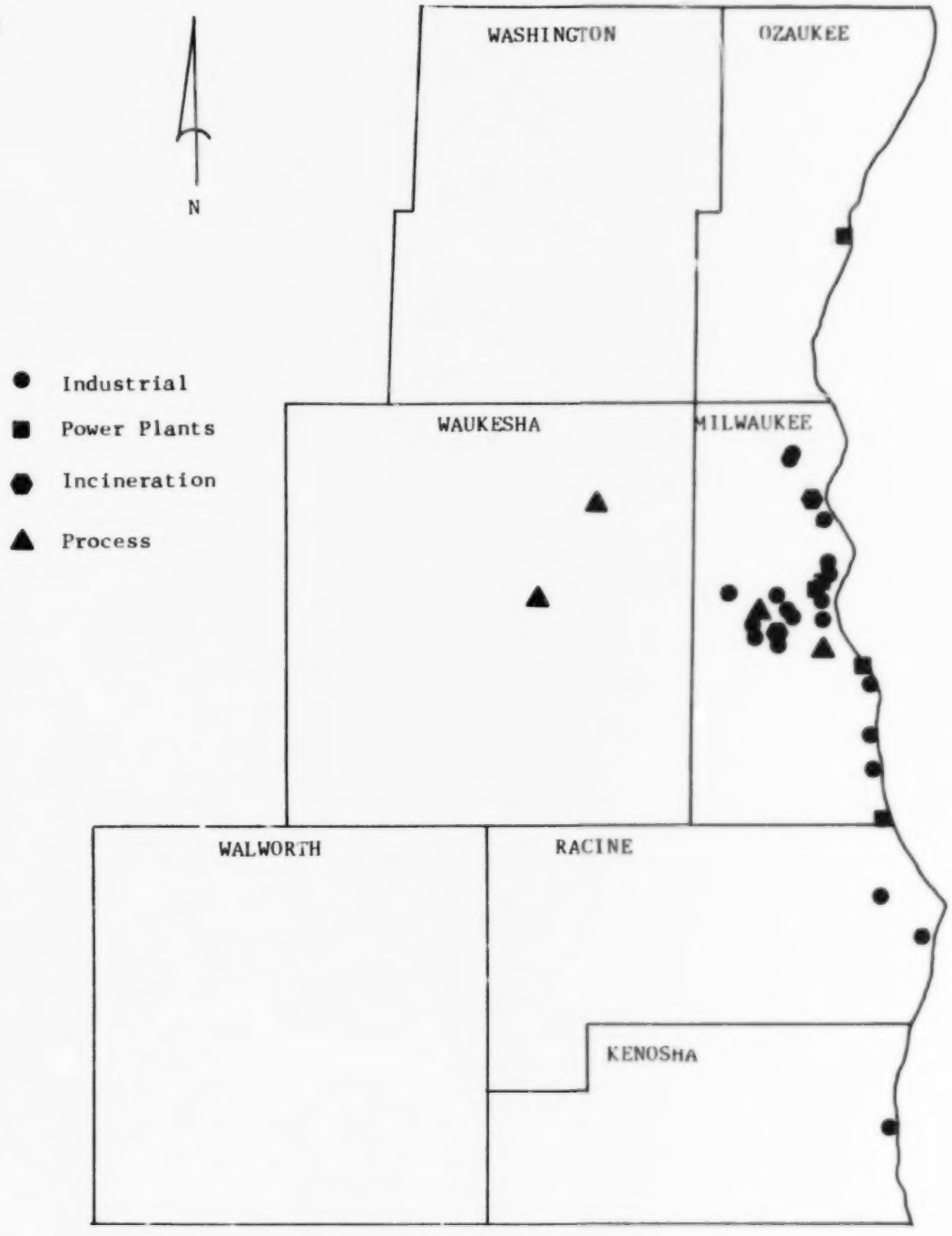


Figure 9. Point Sources that emit 1 ton or more per day of of any single pollutant (SO_X, Particulates, or CO).

extent of the influence of pollution sources on the people and property located outside the highly urbanized portion of the Milwaukee area. A study of air quality levels known or estimated to occur is useful in determining the area affected by the pollution sources and thus subject to inclusion in the Air Quality Control Region. Such analysis can be based directly on air sampling data in those instances where the sampling program covers a large enough area and has been in existance long enough to provide reliable patterns of air quality throughout the region under study. Since such comprehensive air quality data rarely exists, it becomes necessary to develop estimates of prevailing air quality. Diffusion modeling is a technique by which such estimates can be made based on the location and quantity of pollutant emissions and on meteorological conditions. Topography is reflected in the results of the model, but only to the extent that it influences general meteorological conditions.

The diffusion model was applied for each of the three pollutants for an average summer day, winter day, and annual day. Figure 3 and Table 2 show the meteorological data required to apply the model for each of the three average days. Figure 3 shows the percent frequency of occurrence of wind direction from 1951 through 1960 in Milwaukee for summer, winter, and annual conditions. The wind speed and direction data used in the diffusion model were considered representative of the prevailing wind patterns throughout the Milwaukee area. Since the Martin-Tikvart model[1] used in this study attempts to show long-term rather than episodic air quality conditions, only average emissions and long-term meteorology are considered.

The mixing depths for the time periods are averages of the

morning and afternoon values as shown in Table 2; these data were obtained from tabulations prepared by the National Weather Records Center (ESSA). Combined with wind data, these data are used in the diffusion model to assess the spatial distribution of concentrations of suspended particulates, sulfur oxides, and carbon monoxide.

Table 2. Average Mixing Depths for Milwaukee Area by Season

Season	Mixing Depths, meters		
	Average Morning	Average Afternoon	Average, Morning and Afternoon
Winter (Dec.,Jan.,Feb.)	505	630	568
Summer June,July,Aug.)	285	1560	923
Annual (Four Seasons)	420	1134	779

The air pollutant concentration contours produced by the diffusion model are theoretical in nature and are not meant to show exact concentration levels. In this report, the contour maps are used as a guide to help indicate the areas most affected by pollutant emissions in the study area.

Suspended Particulates

Figure 10 shows the diffusion model contours for the Milwaukee and Chicago study areas.* The two sets of contours were produced independently and were based on average meteorology and particulate emissions for each respective study area. Since the two study areas are contiguous, it is assumed that there is some interaction between

* The Chicago study area included six counties in Illinois (Lake, Cook, Will, McHenry, Kane, and Dupage), and two counties in Indiana (Lake and Porter).

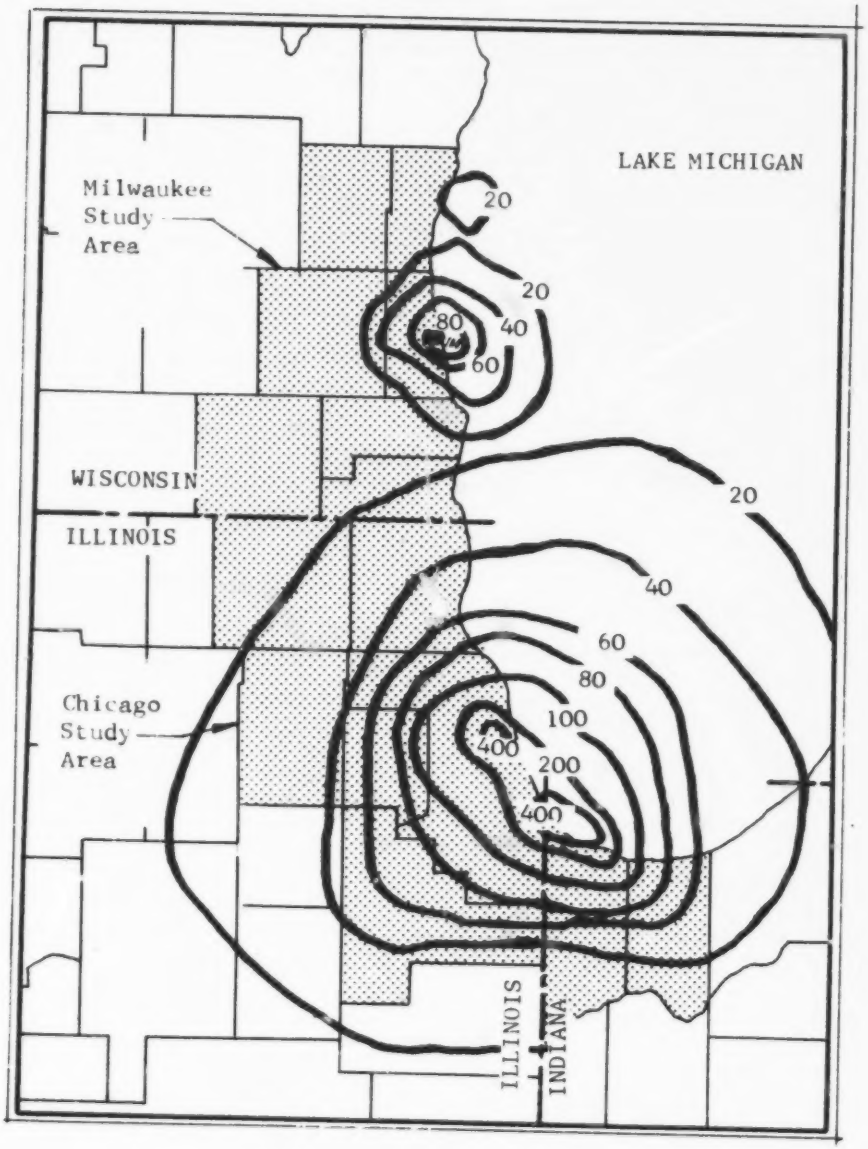


Figure 10. Theoretical particulate concentrations, annual average for Chicago Study Area (eight counties in Illinois and Indiana), and Milwaukee Study Area (seven counties in Wisconsin). Concentrations given in $\mu g/m^3$.

the two. To show the interaction, the contours of Figure 11 were developed based on a summation of the two sets of isopleths in Figure 10.

Comparison of the values for the adjusted isopleths with measured air quality data indicated that theoretical values in the Milwaukee area were generally lower than measured data. This discrepancy may by explained in part by the fact that the theoretical estimates do not take into account background levels of suspended particulates. By adding the assumed background level value (approximately 35 $\mu g/m^3$)* to the contours values, the adjusted values correlate better with measured data. Figure 11 shows the theoretical suspended particulate isopleths after adjustment for the influence of Chicago and for the background-level error. Also shown in Figure 11 are measured suspended particulate data from Milwaukee, Racine, and Kenosha, and a dotted contour representing the background level of 35 $\mu g/m^3$. Although the background level contour line cannot be described exactly, Figure 11 shows that background is reached somewhere in Rock, Walworth, Jefferson, Waukesha, Washington and Sheboygan Counties. The approximate location of the background level contour is important since it is beyond this boundary that the influence of the urban area or areas loses its significance.

Sulfur Oxides

Concentration contours for sulfur oxides are presented in Figure 12. The contours are theoretical; the diffusion model output was adjusted in the same fashion as that for suspended particulates,

* The geometric average of five non-urban stations (1958-1966, 448 samples) in Michigan, Minnesota, Illinois, Iowa, and Wisconsin is 32.5 $\mu g/m^3$. The arithmetic average is 41 $\mu g/m^3$.

Measured Air Quality Data		
Station	Suspended Particulate Level ($\mu g/m^3$)	Time Period
A (Downtown)	169	June '67-July '68
B (Midtown)	91	June '67-Feb. '68
C (Suburban)	90	June '67-Nov. '67 & Mar. '68-July '68
D (Racine)	96	1957-1967
E (Kenosha)	77	1963-1966

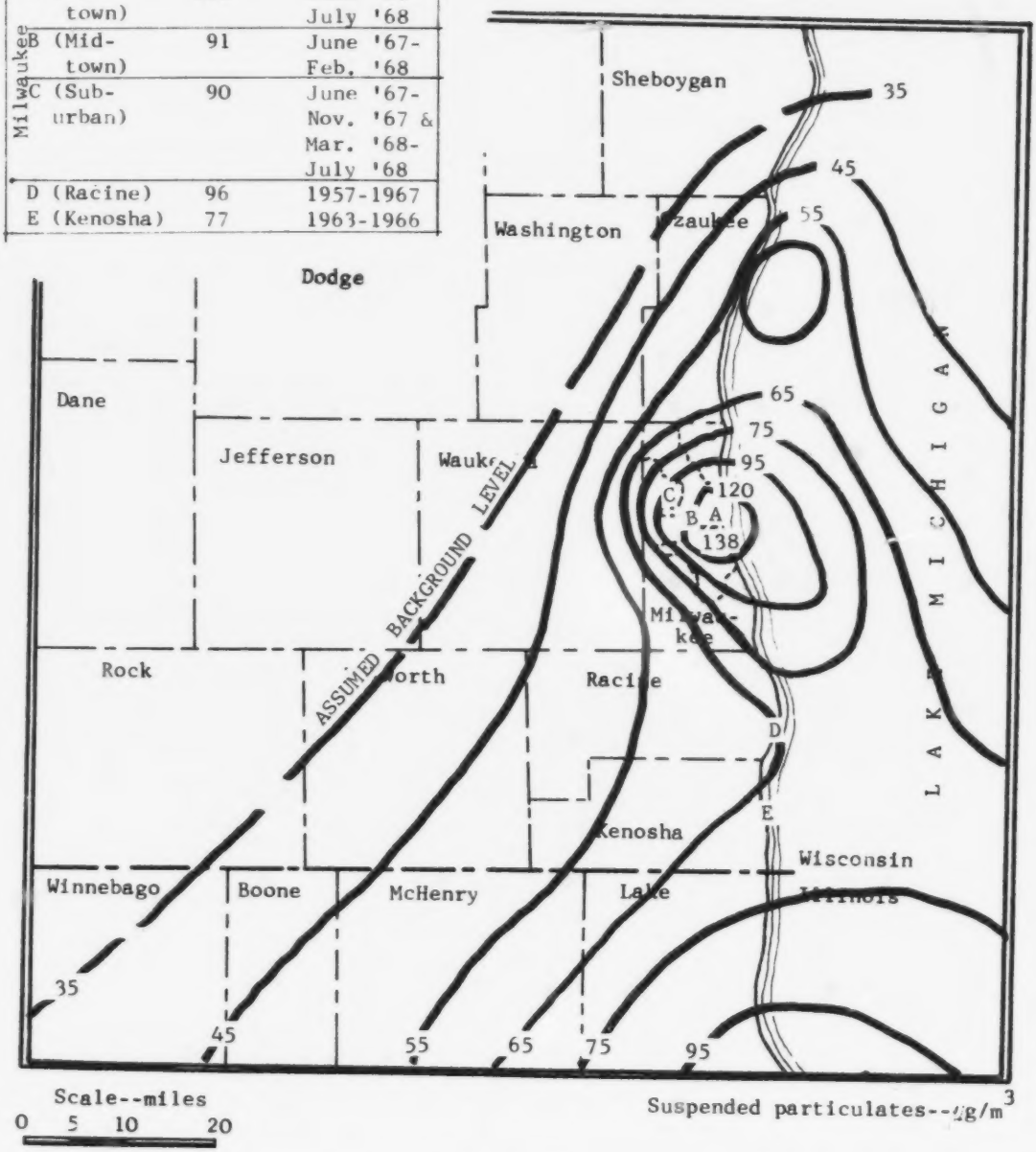


Figure 11. Adjusted theoretical suspended particulate concentration, annual average.

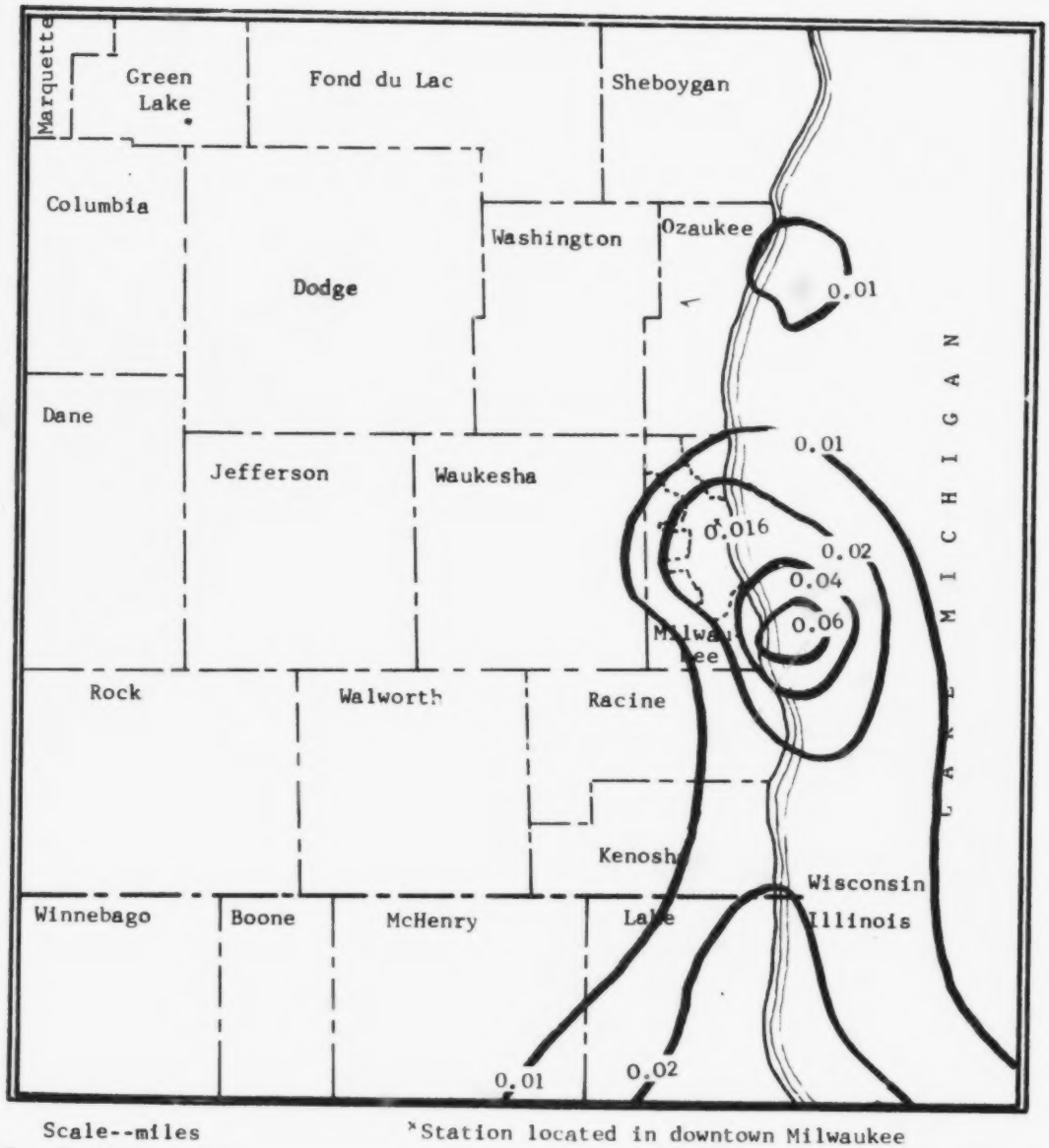


Figure 12. Adjusted theoretical SO_X concentration, annual average.

i. e., a summation of the concentrations was made for the two sets of contours to show the influence of Chicago.

Measured samples were available from only one station in the study area. The SO_2 concentration for January, 1967, to July, 1968, is plotted on the figure. The theoretical values of the contours seem to be high, at least compared to the one station in downtown Milwaukee. Two centers of high concentrations are apparent in Figure 12, and both are attributed to the sulfur oxides emissions from power plants.

Theoretical SO_X concentrations of 0.01 ppm (27 $\mu g/m^3$) and greater are shown in Figure 12. The 0.01 ppm diffusion model isopleth has been used in past air quality control region studies as a guide in determining the size of the region. This value is considered to be close to background levels. Parts or all of the following jurisdictions are encompased by the 0.01 ppm contour: Milwaukee, Waukesha, Racine, Ozaukee, and Kenosha.

Carbon Monoxide

Gasoline-powered motor vehicles are the main contributors of carbon monoxide in most urban areas. In the Milwaukee study area, transportation sources account for approximately 94% of all carbon monoxide emissions.

Figure 13 shows diffusion model contours based on all CO emissions in the area and adjusted to show the influence of the Chicago area. These contours are presented as theoretical relative rather than absolute. Highest relative carbon monoxide levels are found in Milwaukee where traffic density is greatest.

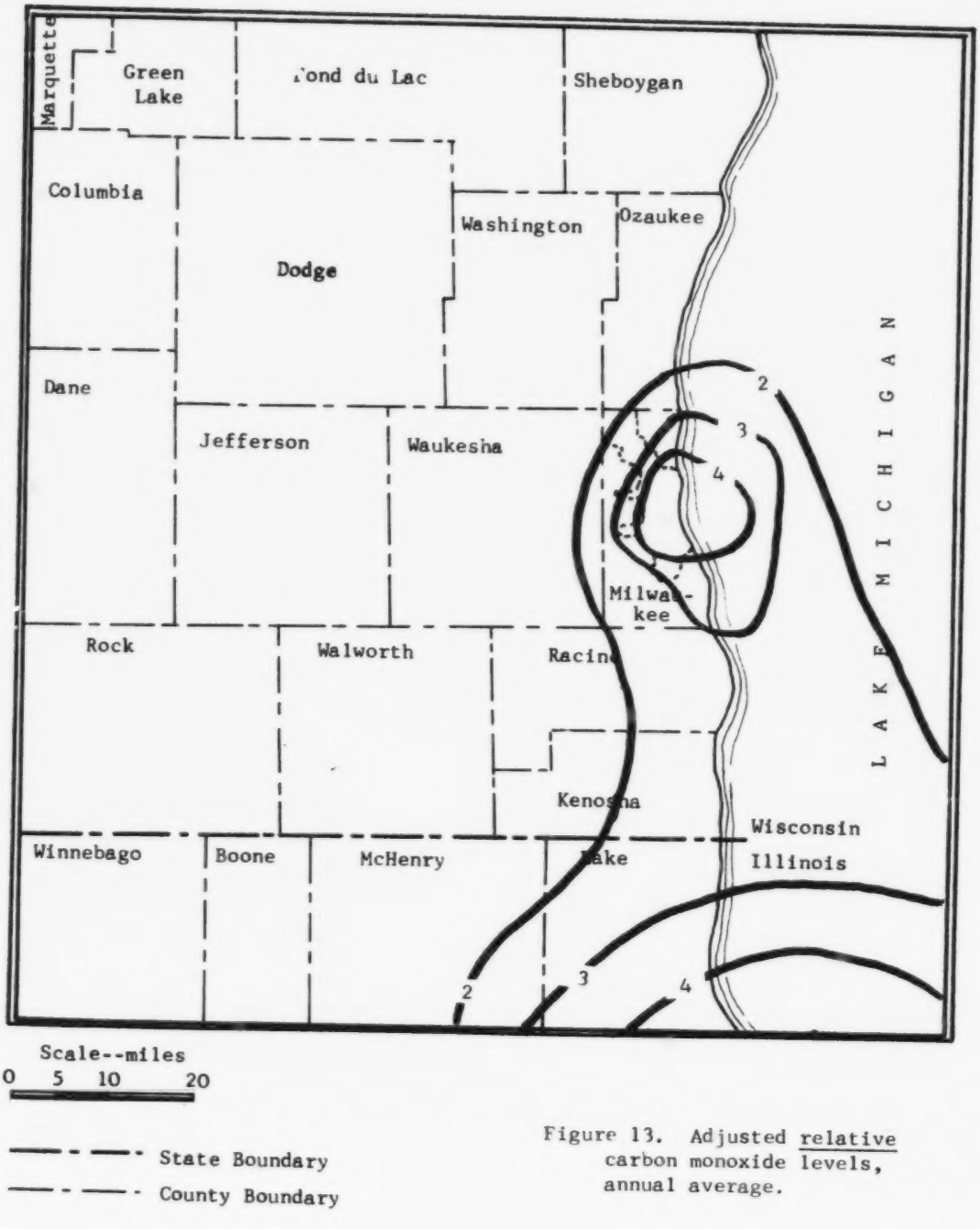


Figure 13. Adjusted relative carbon monoxide levels, annual average.

EVALUATION OF URBAN FACTORS

A number of urban factors are relevant to the problem of defining air quality control region boundaries. The location of population is an important consideration since human activity is the ultimate cause of air pollution, and humans are the ultimate victims. The projected population growth pattern is another important consideration, since an air quality control region should be designed not only for the present but also for the future. The location of industrial activity and industrial growth patterns are relevant considerations for similar reasons. Political and jurisdictional considerations are important since the 1967 Air Quality Act envisions regional air pollution programs based on cooperative efforts among many political jurisdictions. The following discussion of urban factors will present these considerations as they apply to the Milwaukee area.

POPULATION

Figure 14[4] and Table 3 display present population and population densities in Milwaukee and surrounding areas. About 745,000 people reside in the city of Milwaukee. Over one million live in Milwaukee County (includes the city of Milwaukee) which represents 63% of the study area population. Another 28% live in the counties of Kenosha, Racine, and Waukesha; the remaining 9% reside in the three counties of Ozaukee, Walworth, and Washington. Thus, over 90% of the study area population is located in four of the seven counties. This distribution is reflected in Figure 14, which shows population

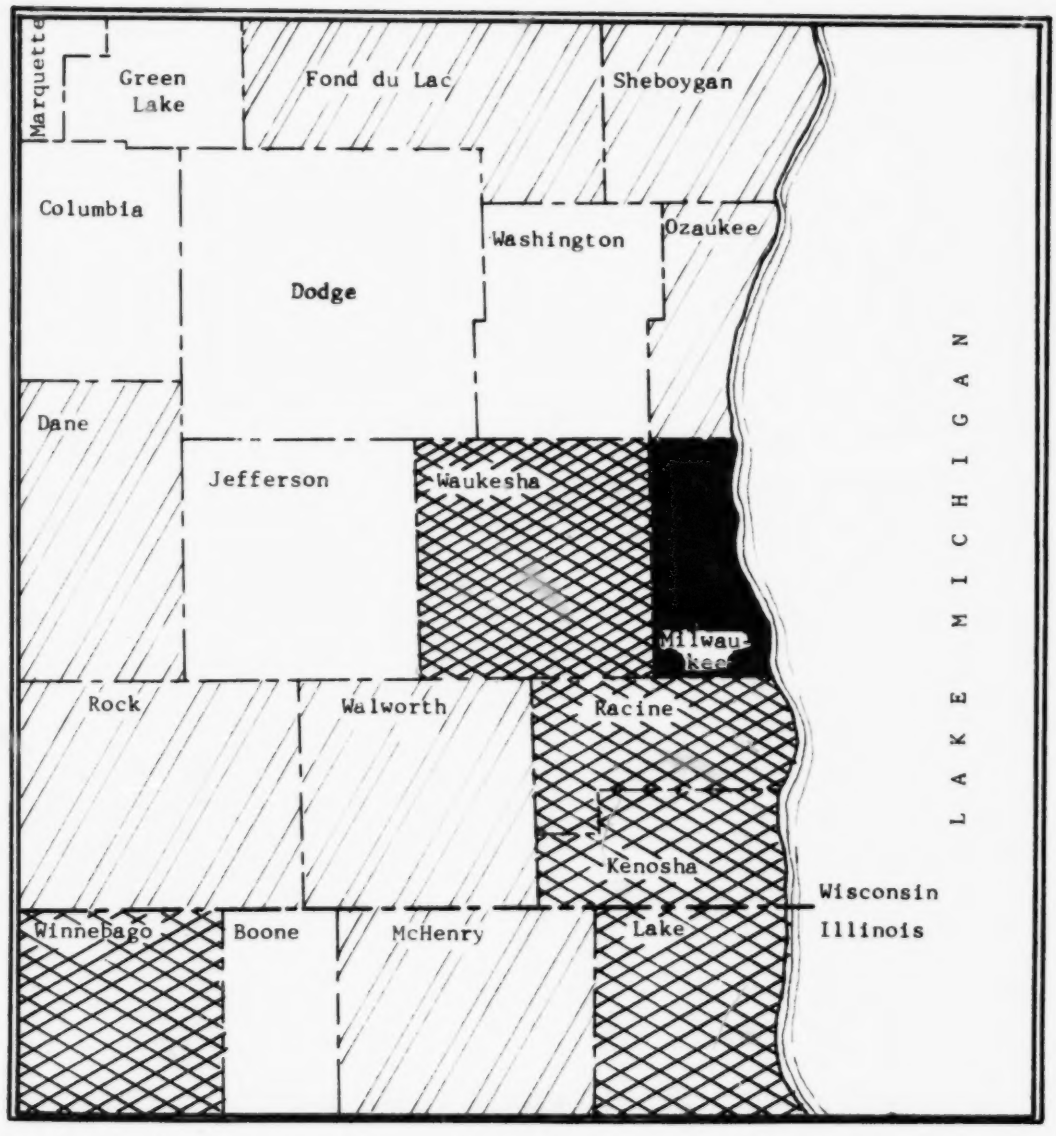


Figure 14. 1968 Population Density

Table 3. Population and Employment Data for Milwaukee Area

County	Area $mi.^2$	Population 1968	Pop. Den. 1968 $res./mi.^2$	Population 1980	Pop. Den. 1980 $res./mi.^2$	Additional Res. per square mile 1968-1980 %	Manufacturing Employment 1963	Manuf. Employ. Density--1963 $Employees/mi.^2$
Columbia	776	37300	48	38700	50	2 (4%)	2542	3
Dane	1198	275000	230	360700	293	63 (31%)	13452	11
Dodge	889	64900	73	70600	80	7 (9%)	6467	7
Fond du Lac	725	77400	107	78200	108	1 (1%)	8560	12
Green Lake	585	15600	27	23600	40	-6 (-10%)	1715	3
Jefferson	564	54200	96	56200	100	4 (4%)	7171	13
Kenosha	272	118000	434	157000	578	144 (33%)	22516	82
Milwaukee	236	1080000	4580	1305000	5540	960 (21%)	75335	320
Ozaukee	236	48000	204	75000	318	114 (56%)	5686	24
Racine	337	164000	486	217000	644	158 (32%)	22185	66
Rock	721	127100	177	149300	207	30 (17%)	17140	24
Sheboygan	505	87900	174	94700	188	14 (8%)	14900	30
Walworth	557	58500	105	73000	131	26 (25%)	5016	9
Washington	817	54000	66	74000	91	25 (37%)	6348	8
Waukesha	555	204000	368	322000	580	212 (58%)	12824	23

density by county. Milwaukee County has the highest population density in the study area with 4580 residents per square mile. Racine, Kenosha, and Waukesha, respectively, follow with densities between 300 and 500 residents per square mile.

Population growth[5,6,7] in the next decade is shown in Table 3 and in Figures 15 and 16. Milwaukee County is expected to show the greatest absolute growth with over 950 additional residents per square mile. Waukesha, Racine, Kenosha, and Ozaukee, respectively, are expected to follow with population increases of over 100 additional residents per square mile. By percent rate of population growth from 1968 to 1980, Waukesha and Ozaukee are predicted to grow most rapidly with increases of over 50%. Washington, Kenosha, Racine, and Dane Counties should experience increases of over 30% while Walworth and Milwaukee Counties are forcasted to grow by 25% and 21% respectively.

In summary, with respect to 1968 population, the core of the study area is Milwaukee County. Waukesha, Racine, and Kenosha also have high population densities. Greatest population growth in terms of additional residents per square mile will also take place in these counties. By percent rate of population growth, Waukesha and Ozaukee are expected to grow most rapidly.

INDUSTRY

Two methods are used to show the location of industrial activity. The first method is based on the density by county of people employed in manufacturing firms. According to 1963 data,[4] Figure 17, Milwaukee County has by far the greatest density of manufacturing

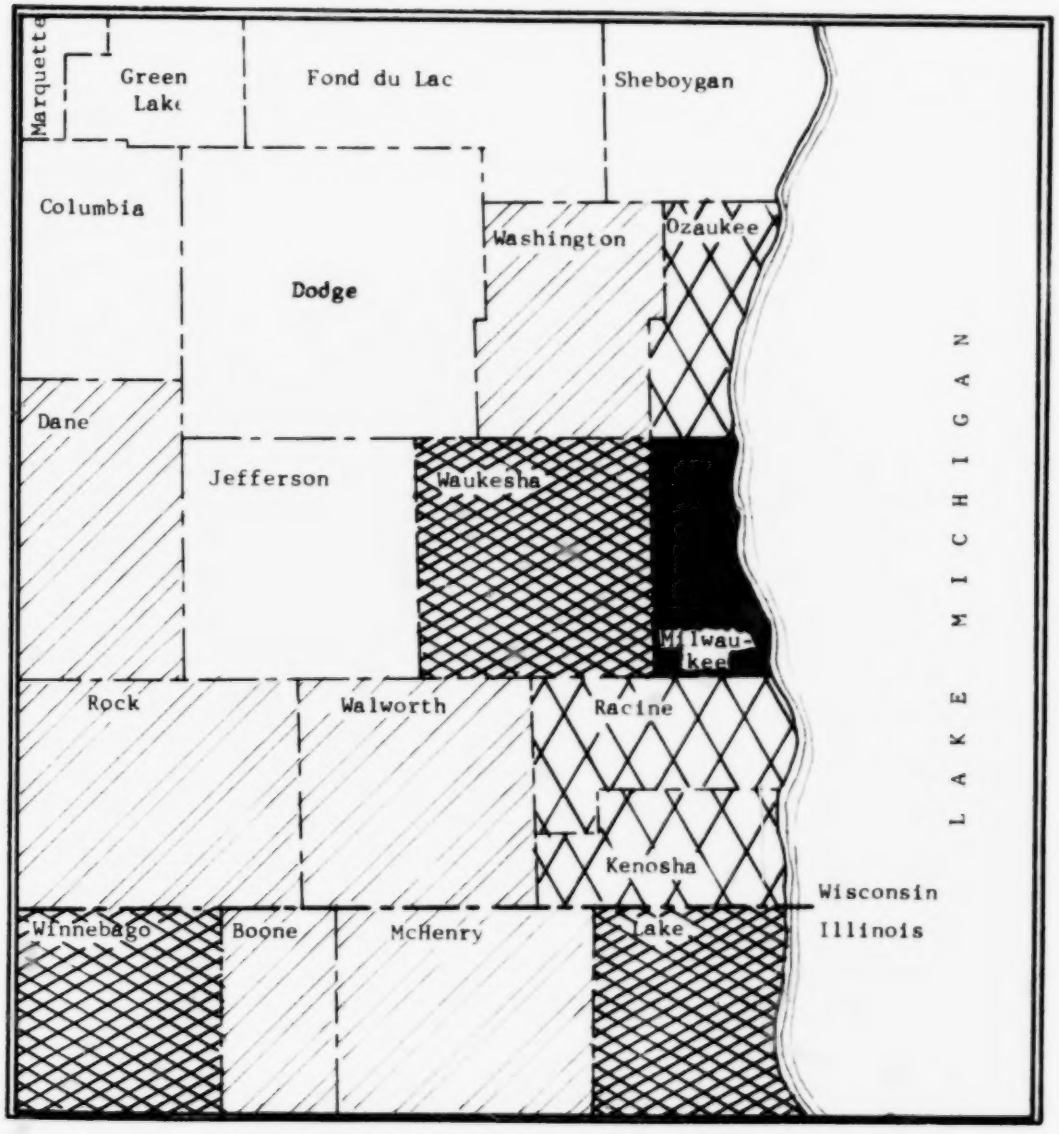


Figure 15. Population Growth, 1968-1980, Expressed in Absolute Terms

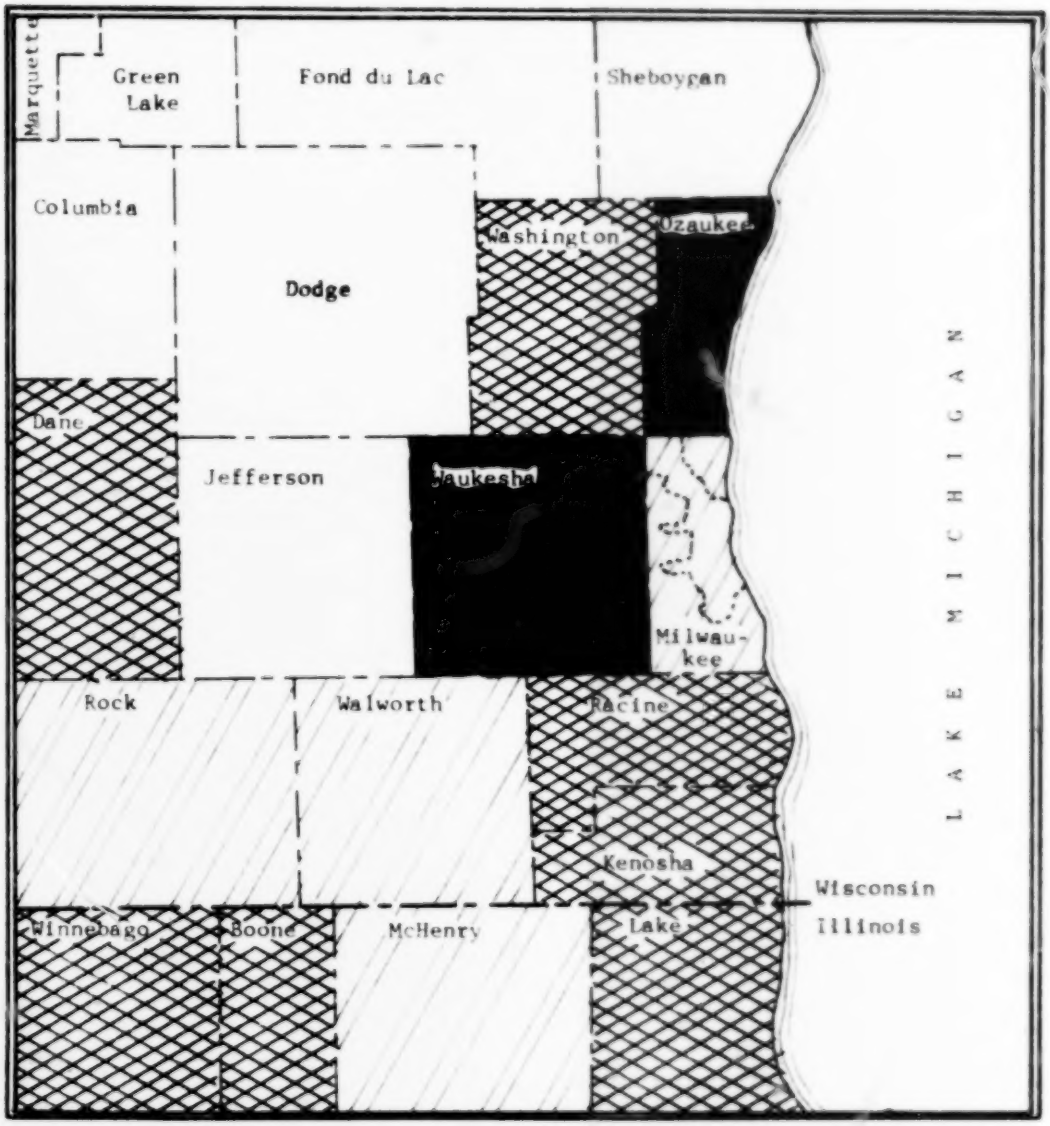


Figure 16. Population Growth From 1968 to 1980 in Percent.

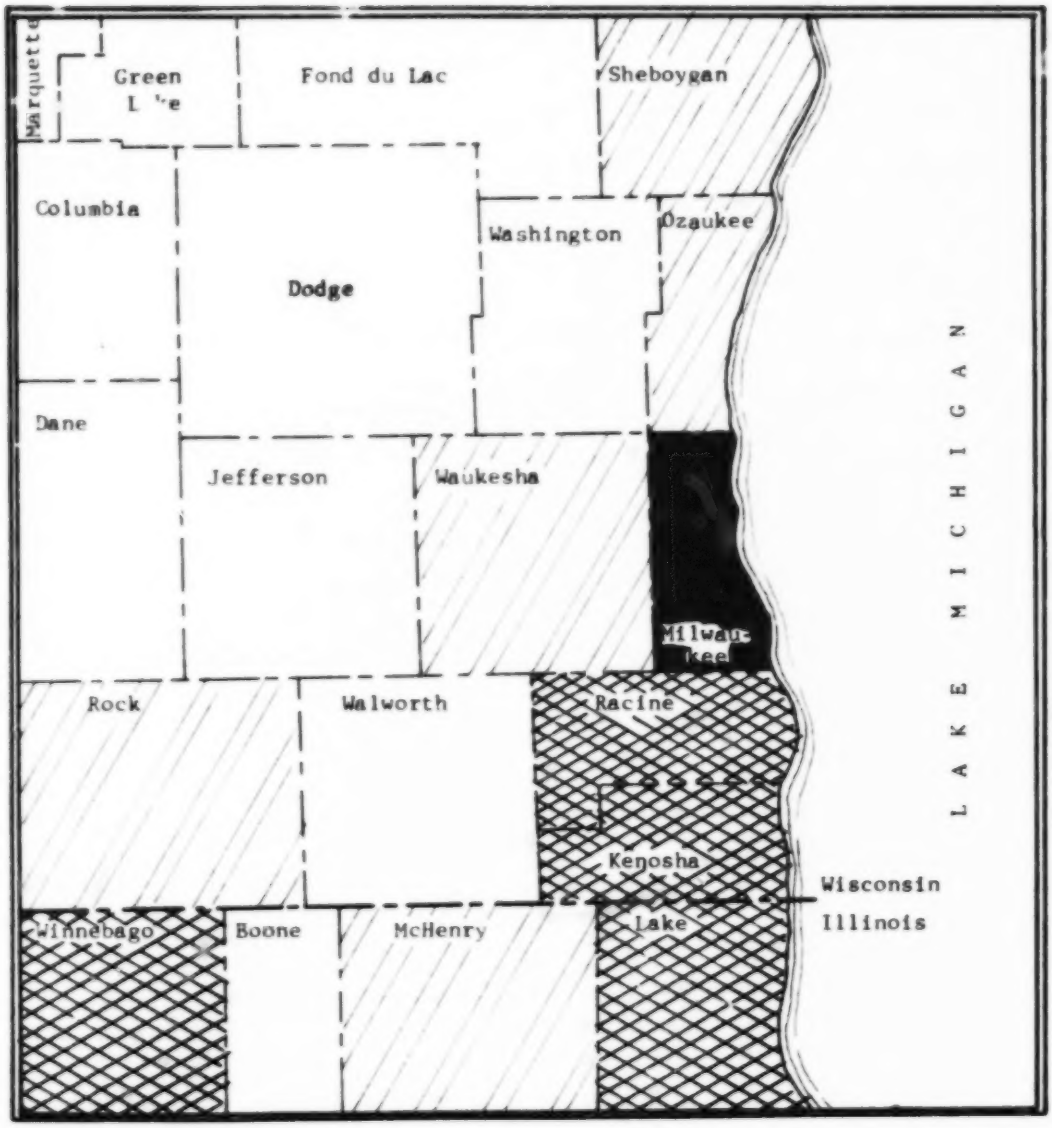


Figure 17. Manufacturing Employment Density (1963)

employees with 320 per square mile. Figure 17 illustrates that most of the manufacturing industry is located in the counties on the Lake Michigan shore. Employment densities fall off rapidly to the west of these counties.

The second method shows the probable general location of major industry in 1990 by the proposed land use map developed by the Southeastern Wisconsin Regional Planning Commission. According to Figure 18,[8] most major industry will still be located in Milwaukee County. Five of the seven counties in the study area, however, are expected to have land devoted to major industry.

AIR POLLUTION CONTROL PROGRAMS

In Wisconsin, responsibility for air pollution control on the state level is charged to the Bureau of Air Pollution Control and Solid Waste Disposal under the Department of Natural Resources, Division of Environmental Protection. Legal authority is granted by Chapter 83, Laws of 1967, which authorizes appropriations for the State and county programs, the creation of an advisory council, and rule-making power. Further, the Law provides the power to conduct informational programs, hold hearings, control motor vehicle emissions, and organize a comprehensive program of air pollution control.

Regarding local programs, the air pollution control law encourages local governmental units to handle air pollution problems in their respective jurisdictions provided their ordinances meet the State's approval and are at least as stringent as those set by State law.

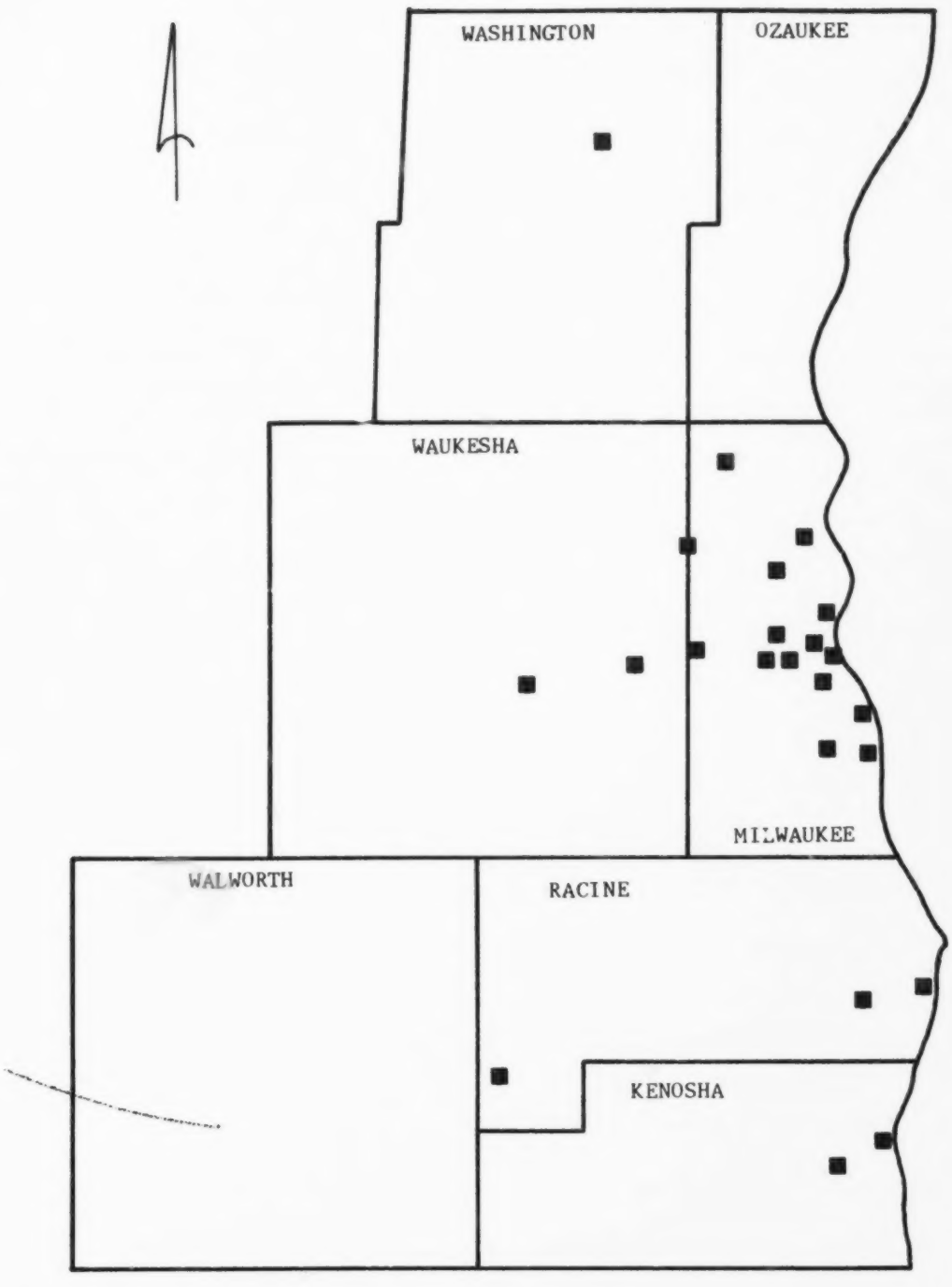


Figure 18. Proposed Major Industrial Land Use, 1990.[8]

Milwaukee County has the oldest program in the state. Control activities are the concern of the Milwaukee County Department of Air Pollution Control, which was created as the Department of Smoke Regulation in 1948. Until 1961 when the Department of Air Pollution Control was formally created, activities of the Department were limited to smoke control. An ordinance was odopted in 1961 (amended in 1964) to regulate smoke and dust particle emissions. The Department was given the authority to promulgate regulations regarding combustion process and incineration emissions.

In 1966, the Department adopted a five-year plan consisting of a ten-point program to improve its existing control program. Included in the ten points are plans for air quality monitoring, public information, rules governing new non-combustion process installations, expanded authority in odor control, and an enforcement program against open burning. Another objective of the plan is to study the possibility of a regional air pollution control program through the Southeastern Wisconsin Regional Planning Commission.

REGIONAL PLANNING IN THE MILWAUKEE AREA[9]

Regional planning in the Milwaukee area is handled primarily by the Southeastern Wisconsin Planning Commission. The area served by the Commission is comprised of seven counties in the southeast corner of Wisconsin: Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha. The seven counties represent about 5% of the area of the State of Wisconsin and about 42% of the State's population.

The Commission was established in 1960 under the Wisconsin statutes and is one of four commissions to be created in Wisconsin to date under the state regional planning enabling act. The Commission is composed of 21 members, three from each county.

The activities of the Commission are numerous and include the collection, analysis, and dissemination of basic planning and engineering data on an areawide basis, the preparation and adoption of a master plan for the physical development of the Region, and the promotion of plan implementation.

THE PROPOSED REGION

Subject to the scheduled consultation, the Secretary, Department of Health, Education, and Welfare, proposes to designate an air quality control region for the Milwaukee area, consisting of the following jurisdictions in Wisconsin:

Kenosha County
Milwaukee County
Ozaukee City
Racine County
Walworth County
Washington County
Waukesha County

As so proposed, the Metropolitan Milwaukee Intrastate Air Quality Control Region would consist of the territorial area encompassed by the outermost boundaries of the proposed jurisdictions. The proposed Region is illustrated in Figure 19. Figure 20 locates the Region in relation to the rest of Wisconsin, the surrounding states and existing air quality control regions.

DISCUSSION OF PROPOSAL

The proposed Region boundaries coincide with the boundaries of the Southeastern Wisconsin Regional Planning Commission. In general, state or locally defined planning regions do not automatically qualify as air quality control regions. However, the Air Quality Act of 1967 requires region boundaries to take into account existing jurisdictions, among other factors. Clearly, a regional planning commission created under a state enabling act is an important jurisdictional consideration. Therefore, this study of the geographic extent of the air pollution problem indirectly evaluates the suitability of the regional planning area as a geographic basis

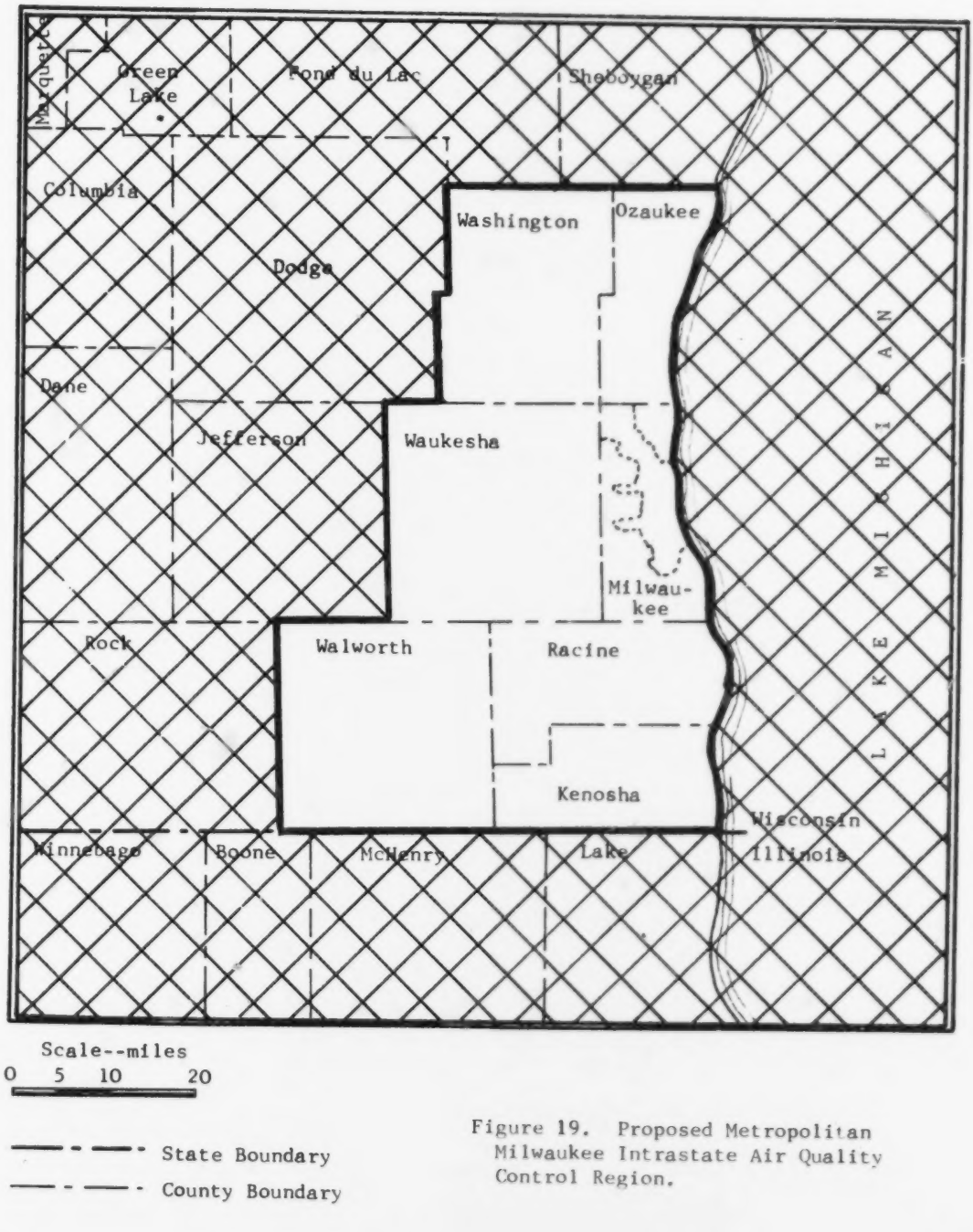


Figure 19. Proposed Metropolitan Milwaukee Intrastate Air Quality Control Region.

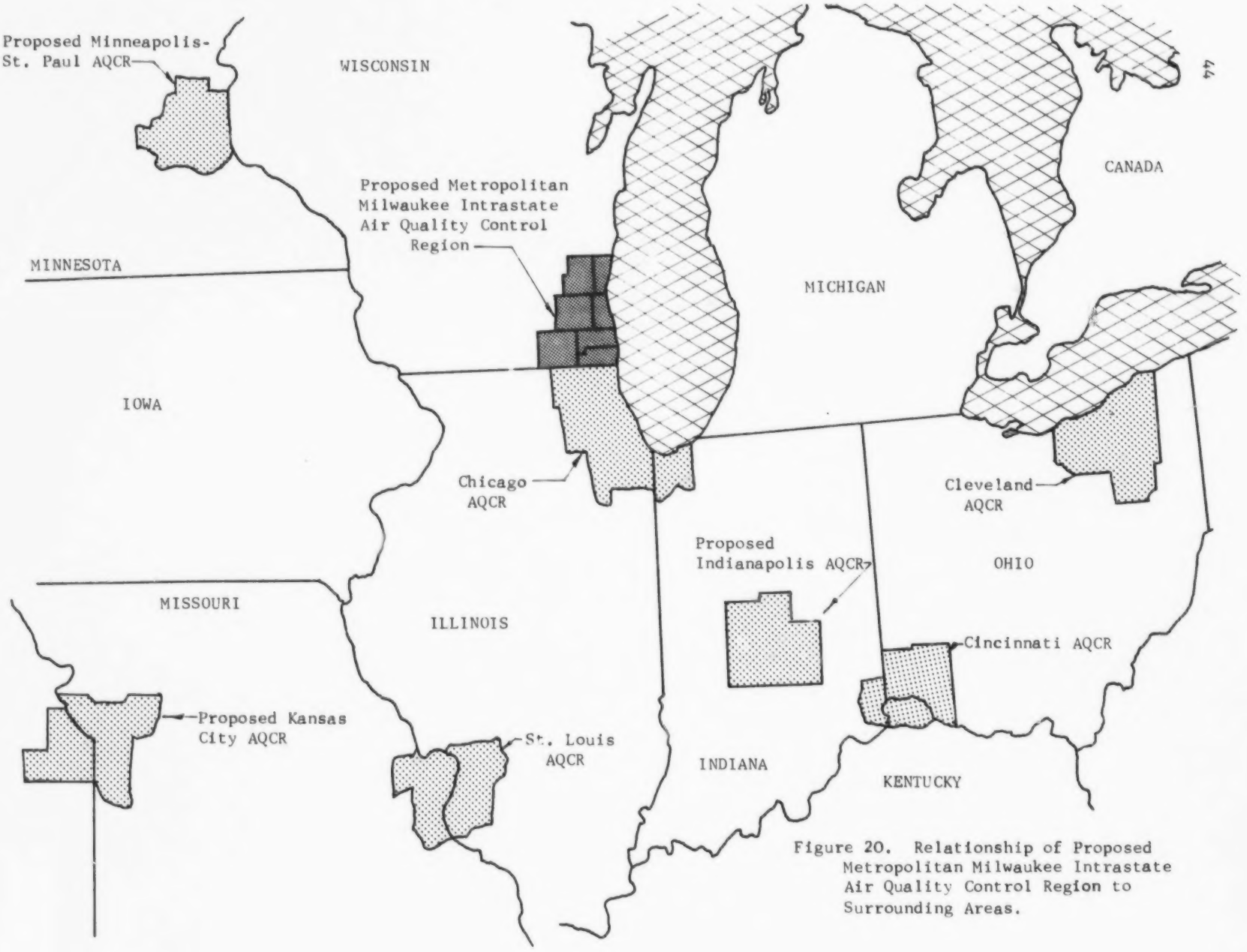


Figure 20. Relationship of Proposed Metropolitan Milwaukee Intrastate Air Quality Control Region to Surrounding Areas.

of attack on the problem. As discussed below, the seven counties in the planning commission area satisfy the three requirements for air quality control region boundaries.

To be successful, an air quality control region should meet three basic conditions. First, its boundaries should encompass most pollution sources as well as most people and property affected by those sources. Second, the boundaries should encompass those locations where industrial and residential development will create significant air pollution problems in the future. Third, the boundaries should be chosen in a way which is compatible with and even fosters unified and cooperative governmental administration of the air resources throughout the region. The "Evaluation of Engineering Factors" (discussion beginning with page 12) discussed the first of these conditions, and the "Evaluation of Urban Factors" (page 31), the second and third.

The first consideration--that most air pollution sources and receptors be within the Region boundaries--is satisfied by the proposed Region. Point sources emitting over one ton per day of any single pollutant (SO_x, particulates, or CO) are located in five counties--Ozaukee, Waukesha, Milwaukee, Racine, and Kenosha. Emission densities of particulates and SO_x are greatest in these five jurisdictions. Carbon monoxide emission densities are fairly evenly distributed throughout the seven counties except in Milwaukee County. Higher densities result here because of the high traffic density.

The theoretical pollutant concentrations contours, produced by the diffusion model and adjusted to reflect measured air quality data and the influence of Chicago, showed that parts of all seven counties have annual suspended particulate concentrations greater than background levels. Sulfur oxides pollution is less wide-spread. Enclosed by the theoretical 0.01 ppm contour are parts of Ozaukee, Waukesha, Milwaukee, Racine, and Kenosha Counties. Milwaukee has the highest levels of carbon monoxide in the study area on the basis of a relative comparison of predicted concentrations.

Over 1,700,000 people live in the proposed Region, which represents over 40% of the population of the State. By including Kenosha and Walworth Counties, the Milwaukee Region becomes contiguous with the Chicago Region.

The second consideration is directed towards future population and industrial expansion. Milwaukee County is expected to register the greatest absolute growth over the next decade with over 950 additional residents per square mile. Four counties--Waukesha, Racine, Kenosha, and Ozaukee are expected to experience population growth of over 100 additional residents per square mile. According to proposed land use map for 1990, Milwaukee County will still have most of major industrial sites. Racine, Waukesha, Kenosha, and Washington Counties will also have some major industry.

The third objective relates to governmental administration in the area. Regional planning is handled by the Southeastern Wisconsin Regional Planning Commission, whose jurisdiction includes the Counties

of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha. The Commission was established in 1960 and consists of 21 members, three from each county.

Based on the technical data presented on air pollutant emissions and resultant ambient air concentrations, only five counties need be part of the Region to attack the air pollution problem. Washington and Walworth are mostly rural at present and are expected to remain so through 1990. Population forecasts support this conclusion. However, since Walworth and Washington Counties have been joined with the other counties in the Regional Planning Commission, it is logical to include them in the Air Quality Control Region for administrative purposes, despite their low air pollution potential.

As is true of most efforts to draw boundaries around an area to differentiate it from surroundings, there is always a likelihood of boundary conditions existing or developing. In the case of air quality control regions, such a boundary condition would exist where sources of pollution on one side of the Region boundary affect in some real way air quality on the other side of the boundary. Relocating the boundary would only rarely provide relief from this condition. The solution is to be found in the way in which control efforts are implemented following the designation of an air quality control region. Consonant with the basic objective of providing desirable air quality within the problem area being designated as an air quality control region, the implementation plan that follows the designation should have provisions for the control of

sources located close to but beyond the region boundaries. The level of control for such sources should be a function of, among other factors, the degree to which emissions from sources cause air quality levels to exceed the standards chosen for application within the Air Quality Control Region.

In summary, the Region proposed is considered on the whole to be the most cohesive and yet inclusive area within which an effective regional effort can be mounted to prevent and control air pollution in the Milwaukee area.

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☆ U. S. GOVERNMENT PRINTING OFFICE : 1969 O-395-666 (5001)